Published in final edited form as:
Am J Surg. 2011 November ; 202(5): 511–514. doi:10.1016/j.amjsurg.2011.06.017.

Frailty Predicts Increased Hospital and Six-Month Healthcare Cost Following Colorectal Surgery in Older Adults

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Abstract

BACKGROUND—The purpose of this study was to determine the relationship of frailty and six-month post-operative costs.

METHODS—Subjects ≥65 years undergoing elective colorectal operations were enrolled in a prospective observational study. Frailty was assessed by a validated measure of function, cognition, nutrition, co-morbidity burden and geriatric syndromes. Frailty was quantified by summing the number of positive characteristics in each subject.

RESULTS—Sixty subjects (mean age 75±8 years) were studied. Inpatient mortality was 2% (n=1). Overall, 40% (n=24) of subjects were considered non-frail, 22% (n=13) were pre-frail and 38% (n=22) were frail. With advancing frailty, hospital cost increased (p<.001) and cost from discharge to six-months increased (p<.001). Higher degrees of frailty were related to increased rates of discharge institutionalization (p<.001) and thirty-day readmission (p=.044).

CONCLUSIONS—A simple, brief pre-operative frailty assessment accurately forecasts increased surgical hospital costs and post-discharge to six-month healthcare costs following colorectal operations in older adults.

Keywords

Geriatric; Surgery; Financial; Frailty; Healthcare resources

INTRODUCTION

More than half of all operations in the United States are performed on persons 65 years and older.[1] Healthcare spending consumes 16% of the United States' gross domestic product. Therefore, understanding factors that increase surgical-related healthcare costs in older adults is important.

The healthcare-related costs of surgery extend beyond the in-patient setting, and include the consumption of resources after hospital discharge. While reported cost of an operation is

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This abstract was presented at the 2011 AVAS Meeting in Irvine, California

typically truncated at the end of the hospital stay, the pressures of shorter hospital stays on an aging population require increased post-discharge resources.[2] The Center for Medicare and Medicaid Services (CMS) is the largest healthcare purchaser in the United States.[3] Medicare reimburses hospital cost based on diagnostic related groups.

Older adults have unique physiologic vulnerability, called frailty. Frailty is defined as a state of reduced physiologic reserve associated with increased susceptibility to disability.[4] Adverse surgical outcomes related to frailty include increased hospital complications, length of stay, need for discharge institutionalization and mortality.[2, 5] The relationship between frailty and post-operative healthcare costs is not known.

The purpose of our study was to determine the relationship of frailty burden to both hospital and six-month health care costs following colorectal operations in older adults. Comparing groups defined by burden of frailty, the specific aims included: (1) Quantify hospital and post-discharge healthcare cost from the time of an operation until six months post-operatively. (2) Compare pre-operative co-morbidities, intra-operative variables and post-operative variables as potential confounders. (3) Compare the actual hospital stay cost to the Medicare diagnostic related group payment.

METHODS

Subjects included in the study were 65 years or older undergoing elective colorectal operation between 01/07 and 04/10. Exclusion criteria were abdominal perineal resection, patients with acute blood loss anemia (in whom anemia is not from chronic disease) and emergency operations (in whom baseline frailty cannot be ascertained). This study was performed at the Denver VA Medical Center and was IRB approved (COMIRB05-0281).

To quantify the presence of frailty in an elderly individual, abnormalities across frailty domains (e.g, function, cognition, nutrition, chronic disease burden, geriatric syndromes) are summed and the accumulation of frailty characteristics is used to describe the level of an individual's frailty.[6] The seven characteristics which our previous work found to be most closely associated with adverse post-operative outcomes were used in this study: Timed Up-and-Go ≥ 15 seconds (the timed up and go measures the time it takes for an individual to rise from a chair, ambulate ten feet, return to the chair and sit back down, dependence ≥1 activity of daily living (determined by asking about dependence in at least one activity including bathing, dressing, toileting, transferring, continence, and feeding), Mini-Cog score ≤ 3 (combination of a three item recall and clock draw test to assess cognition), albumin <3.4 g/dL, Charlson Index score ≥3, Hematocrit <35%, and ≥1 fall in the six-months prior to the operation (ask if they have fallen in past six-months).[2, 5]

To quantify frailty, a frailty score was determined for each subject. The clinical measurements which assessed the domains of frailty were defined as positive (meaning the assessment was abnormal) as described in the previous paragraph. The number of positive measurements in each subject was summed to create a number of the accumulated abnormal characteristics. After summing the accumulated number of frailty characteristics in each subject, frailty was defined in an ordinal fashion: non-frail (0 and 1 abnormal characteristics), pre-frail (2 and 3 abnormal characteristics) and frail (4 to 7 abnormal characteristics).[2]

The primary outcome variable was healthcare cost. Cost data was obtained from the Decision Support System (DSS) which is a dataset that estimates the cost of individual hospital stays and health care at the VA. Total health care cost for six-months following the operation were recorded which included cost of the hospital stay and healthcare cost

following operative hospital discharge. To address potential confounders, routine pre-, intra-, and post-operative variables were recorded.

The Center for Medicare and Medicaid Services (CMS) inpatient prospective payment system diagnostic related group (DRG) payment was determined for each surgical hospital stay. Diagnostic related groups classify surgical procedures and define a bundled reimbursement rate provided to the hospital following the surgical hospital stay. Medicare diagnostic related groups were used because study participants were 65 years and older (a demographic similar to Medicare's population). Diagnostic related groups used for this study were based on Denver regional wage rates and included indirect medical education costs (both factors included to mimic the care at the Denver VA).

Descriptive statistics reported as mean (± standard deviation). Because the data was not normally distributed, continuous variables were compared using the Kruskal-Wallis Test. Categorical variables were compared with the Chi-squared test. Spearman rho correlation coefficient was used to determine the strength of the correlation of frailty groups to actual hospital cost and diagnostic related group payment.

RESULTS

Sixty subjects (58 male) were studied with a mean age 75±8 years. Average length of stay was 7±7 days. Inpatient mortality was 2% (1). Six-month mortality was 8% (5). The study group was made up of 40% (24) non-frail, 22% (13) pre-frail and 38% (23) frail individuals. Two subjects resided in a nursing home prior to surgery and returned to their nursing home after surgery (both were in the frail group).

Following colorectal operations in all 60 subjects, $2,808,995 was spent for surgical hospital costs and $1,279,484 was spent from hospital discharge to six-months post-operatively. A total of $4,088,479 ($67,308 per subject) healthcare dollars were spent in the total six-month post-operative period. For every $1 spent on the surgical hospitalization, $0.46 is spent following the hospital stay until six-months postoperatively (representing 31% of total healthcare dollars). Cost of surgical hospitalization, cost from discharge to six-months post-operatively and total six-month post-operative cost all increased with higher degrees of frailty. (see Table I)

Pre-operative, intra-operative and post-operative variables were compared in non-frail, pre-frail and frail groups. (see Table I) Baseline pre-operative co-morbidities and intra-operative variables were similar in the three groups. Increasing frailty burden was associated with older age ($p<.001$). Need for discharge to an institutional care facility ($p<.001$) and thirty day readmission rates ($p=.044$) increased with increasing frailty. Stratifying subjects in three frailty groups had stronger correlation to actual hospital cost (Spearman's rho correlation coefficient .664) in comparison to Medicare DRG Payment (Spearman's rho correlation coefficient .320). (see Table I for cost data)

DISCUSSION

The purpose of our study was to compare baseline pre-operative frailty to six-month health care costs following colorectal operations in individuals 65 years and older. Accumulation of a higher number of positive frailty characteristics correlated with increased surgical hospital costs, increased cost from time of discharge to six-months post-operatively and increased total six-month healthcare costs. Increased cost from time of discharge to six-months following surgery was likely due to increased need for discharge to an institutional care facility and higher thirty day readmission rates in frail individuals. Pre-operative and intra-operative variables were similar in the three frailty groups except for increasing age

which was associated with increasing frailty. Therefore, advancing age may confound the relationship between increasing post-operative healthcare costs and burden of frailty. Increasing burden of frailty was superior to Medicare's diagnostic related groups at determining surgical hospital cost.

The ability to predict hospital cost following an elective operation has been elusive.[7–8] Riordan and colleagues found that traditional pre-operative risk stratification based on baseline co-morbidities and end-organ dysfunction were poor predictors of post-operative cost.[8] Using a different strategy, Dimick and colleagues suggest post-operative complications are a major factor driving surgical costs.[9] Medicare includes pre-operative co-morbidity, operation complexity and post-operative complications to determine diagnostic related group payments. The current study quantifies risk pre-operatively using a simple, brief frailty assessment that takes around 5 minutes to complete.

The advantage of the current approach is that the entire assessment is completed pre-operatively, which allows the potential to alter clinical management. Currently, the most promising area of intervention aims to improve function through exercise regimens with the potential to optimize healthcare outcomes.[10] Other potentially modifiable frailty domains include cognitive stimulation and nutritional supplementation. For elective, non-essential operations (such as colostomy takedown), the clinician may use high frailty burden to counsel the patient on anticipated poor outcomes to alter surgical decisions.

The importance of our study is twofold. First, the true cost of an operation to a society on an older adult does not stop at the time of hospital discharge. Roughly 30% of healthcare dollars spent in the six-months following an operation occur after hospital discharge. Second, a simple, brief pre-operative frailty assessment provides valuable insight into which patients will have high healthcare costs following a major operation. Assessing frailty pre-operatively is a complete paradigm shift from traditional pre-operative risk assessment which focuses on single end organ dysfunction.[5] The ability to define prior to surgery which patient will consume a disproportionate amount of healthcare resources allows the potential to alter that individual's care plan.

The main limitations of our project were twofold. First, our study used only one of the two current contesting methods to quantify frailty.[6, 11] By investigating only one of these two methods, this study is not able to assess the efficacy of both frailty definitions. Second, the majority of individuals in this study were male. As a result, a gender bias of frailty's relationship to post-operative cost cannot be determined.

In summary, pre-operative baseline frailty is associated with six-month post-operative healthcare costs. Future directions of this work include developing specialized care plans (or teams) to optimally manage frail individuals following major operations and to implement strategies to modify risk of the frail individual.

Acknowledgments

Financial Support: Paul B. Beeson Award – NIA K23AG034632 (TNR); Dennis W. Jahnigen Award - American Geriatrics Society (TNR); NIH K24-HL-089223 (MM).

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Table I

Patient and Operative Characteristics Based on Frailty Group

	NON-FRAIL (0&1 trait) (n=24)	PRE-FRAIL (2&3 traits) (n=13)	FRAIL (≥4 traits) (n=23)	p-value
Hospital Cost	$27,731±15,693	$29,776±12,782	$76,363±48,595	<.001
Post-Hospital 6-Month Cost	$6,472±7,523	$21,874±13,018	$34,339±31,756	<.001
Total 6-Month Post-Op Cost	$33,453±17,870	$51,650±21,569	$110,702±67,705	<.001
Medicare DRG Payment	$23,142±6,751	$25,425±5,234	$27,399±3,148	.028
Baseline Health				
Age	70±5	75±6	81±6	<.001
Prior Stroke	8% (2)	0 (0)	13% (3)	.397
Hypertension	67% (16)	69% (9)	74% (17)	.861
Creatinine	1.1±0.2	1.2±0.3	1.2±0.3	.108
COPD	13% (3)	22% (2)	26% (6)	.462
Diabetes Mellitus	4% (1)	31% (4)	17% (4)	.089
Body Mass Index (kg/m^2)	27±4	24±6	26±4	.124
Operative Variables				
Operative Time (Minutes)	173±42	177±47	170±42	.658
Estimated Blood Loss (ml)	133±95	183±130	189±167	.312
Laparoscopic (not open)	71% (17)	77% (10)	52% (12)	.242
Site of Operation				.313
Right Colectomy	42% (10)	54% (7)	22% (5)	
Left Colectomy	25% (6)	15% (2)	22% (5)	
Sigmoid Colectomy or LAR	25% (6)	31% (4)	35% (8)	
Colostomy Takedown	8% (2)	0 (0)	22% (5)	
Tumor Stage				.455
Benign	38% (9)	23% (3)	30% (7)	
Stage 1	29% (7)	23% (3)	22% (5)	
Stage 2	21% (5)	15% (2)	30% (7)	
Stage 3	8% (2)	23% (3)	17% (4)	
Stage 4	4% (1)	15% (2)	0 (0)	
Post-Discharge Variables				
Discharge Institutionalization	0 (0)	15% (2)	59% (13)†	<.001
30-Day Re-Admission	4% (1)	15% (2)	32% (7)†	.044

DRG – Diagnostic Related Group; COPD – Chronic obstructive pulmonary disease; LAR – Low Anterior Resection;

† - n=22 because one frail subject died during their hospital stay